Table of contents.

1. System Overview.

2. Installation Procedures.

   A. Installing HYDRA.
   B. Initialising HYDRA.
   C. Executive sites.
   D. Installation errors.
   E. Network Connection.
   F. Network Termination.
   G. First steps in communication.

3. Inter-program communication.

   A. NPRINT: Send a message to a remote site.
   B. NINPUT: Receive a message from a remote site.
   C. NPEEK: Peek the contents of a remote site's screen.
   D. NPOKE:
      D.1 Poke a program into a remote site.
      D.2 Poke screen contents.
   E. N>: Return local Site ID into ST.
   F. N+; N-: Operate sounder.
   G. NSTOP: Exit HYDRA.

4. Remote file handling.

   A. General Description.
   B. NREM: Specify a remote site.
   C. NLOAD: Load a program from a remote site.
   D. NSAVE: Save a program to a remote site.
   E. NOPEN: Open a file at a remote site.
   F. NCLOSE: Close a file at a remote site.
   G. NCMD: Spool screen output to a remote file.
   H. NPRINT#: Write data to a remote file.
   I. NINPUT#: Read data from a remote file.
   J. NGET#: Get a character from a remote file.
   K. NRECORD#: Define the next record to be processed.
   L. NCATALOG: Display disk directory.

5. Program control.

   A. General description.
   B. Substitute characters.
      B.1 Quotes.
      B.2 Carriage return.
      C.3 Escape substitution.
      D.4 Break key.
   C. NRUN: Control of a local program.
   D. NRUN: Control of a remote program or site.

6. Program function keys.

   A. General description.
   B. Saving a new function.
   C. Invoking a saved function.
   D. Deleting a saved function.
   E. Displaying functions.

7. General Notes on HYDRA useage.

8. Programming Examples.

   Appendix A Command summary.
   Appendix B Error message summary.
   Appendix C Index.
   Appendix D Executive sites.
   Appendix E Machine-code Entry Points.

SYSTEM OVERVIEW

The HYDRA Networking System for the range of CBM Computers can best be described as a customised Local Area Network, or LAN. The custom approach has been necessary for two reasons. Firstly, in order to maintain total CBM Operating System compatibility certain technical procedures are necessary which are incompatible with classical LAN architechtures. Secondly, the evolution of Networking Standards is continuing at this time, and it is not expected that a single Standard will be adopted for either Hardware or Protocol Structures. So, in order to create a product it was necessary to define these two aspects at the outset using the following guidelines:

* The Network must run at the maximum speed attainable by any attached CPU or Device.
* The Network must also be capable of operating at a reduced frequency to allow slower peripherals or processors to communicate.
* The connecting medium should be inexpensive and readily available to the user. Attachment to it should be straight-forward.
* All Network Nodes or Sites should be completely autonomous and able to access the Network on an equal basis.
* The Network must be fail-safe, in that failure of a device or power to a device, or abuse of hardware or software or the Network medium will not bring down the Net or corrupt data in transit.
* Addition of the Network facility to a device should not impact existing Software or Hardware functions within that device.

Several physical configurations were considered, but found to be incompatible with one or more of these guidelines. Rings or closed-loop systems will not tolerate the kind of accidental abuse to be found in a commercial environment, nor are they easily reconfigured to include or exclude nodes, as loop continuity must be maintained. Node device failure of any kind will bring down the Net, as the transmission protocols generally in use with Ring systems rely on Token or Packet-passing from one device to the next around the loop. It is also obvious that all Nodes must be powered and active at all times, a requirement that is very difficult to achieve when the Network is host to multiple processors spread over a distance of one kilometre, each of which is likely to be performing a totally different function.

All SDLC and HDLC configurations assume the presence of one Primary and one or more Secondary stations (or nodes). This is sometimes referred to as a Master-Slave configuration. Secondary nodes may not communicate between themselves and may only talk to the Primary or Master node. It can be seen that at conventional microprocessor speeds, the work load endured by such a Master can lead to data traffic congestion, with resulting degradation of Network efficiency and system throughput. Evaluation tests have shown that the maximum practical Master-Slave Network size for a system comprised of 8-bit microprocessors is around 8-10 devices, depending on work loading.

The configuration chosen for HYDRA is usually referred to as CSMA, which is short for Carrier Sense Multiple Access technique. The Net is a single multi-drop highway which all nodes may access according to a defined convention; a device requiring to talk on the Network simply waits until no other is transmitting, then talks. If the Net is busy, the node will recognise this by Sensing the presence of a Carrier frequency on the Net, and will wait for a gap in the data traffic. Similarly, its presence on the Net will preclude other site transmissions. This is a dramatic simplification of the technique, which in fact must embody sophisticated algorithms to handle collision sensing/avoidance procedures, multiple access arbitration, transmission handshaking, and general traffic protocols on the Net.

The Network specification derived for HYDRA satisfies all of the guidelines given here, in most cases exceeding required performance and safety margins, and in fact setting new standards for Network resilience.

The Network medium is a simple 4-wire highway which attaches to all devices on the Net. The system speed for this implementation is 250,000 Baud, which is the maximum sustainable rate for a 1Mhz 6502 CPU. In byte terms this represents around 30,000 characters per second, equal to the entire memory capacity of standard CBM micro-computers. Under adverse line conditions (e.g. electrical interference from heavy machinery) or when communicating with slower devices, each HYDRA node may reduce the transmission rate according to its needs. This is transparent to the user, and is made possible by the data-clocking techniques built into each node. There is no Master clock for the system, each node defines the rate at which it will transmit; this means that the Net is not obliged to run at the speed of the slowest participant, but can change to match any requirement. For all CBM microcomputers the nominal data rate will be 250KBaud. It can be seen that for most data transmissions, Net occupation time will be measured in milliseconds, and it is this speed/Net-time ratio that allows a Multiple-Access configuration to achieve high efficiency and utilisation levels.

This speed by no means approaches technical maximums; state-of-the-art LAN's are currently rated at 10MBaud. However, such exotic networks are extremely costly and will represent a significant overkill for most microprocessor-based systems.

HYDRA node traffic is formatted and output to the Net by a plug-in memory-mapped printed-circuit board resident in each CBM computer. One board type and one software version serves all current models and BASIC revisions. All boards are identical and can be interchanged between all CBM models available at this time. Each node is completely autonomous and may communicate with any other currently active. Nodes may be physically added or removed, or switched on and off, at any time without detriment, and the Net will survive short-circuits of small duration without adverse effect on transmissions or data integrity. A hardware auto-crowbar function prevents any node from occupying the Net for longer than 2 seconds at one time; this ensures that a system crash within a node will not bring down the Net by transmitting indefinitely.

Software resident on the node board provides both fundamental data handling/network control and a range of powerful utilities based around the remote manipulation of CBM computers and peripherals. Although the machine-code on-board runs to 8KBytes and operates in the range 9000-AFFF (expansion ROM space), software switching of the ROMs allows the user to run commercially available software in the 9000-9FFF range, and provision is made on the HYDRA board for user ROM or EPROM. ROM switching is completely automatic and transparent to the user program. Also embedded in each node is the Command structure for the networked ERIX Hard-Disk Operating System.

A Multi-User DOS is loadable from CBM disk and provides each CBM computer and its disk unit with the ability to maintain 50 open Files of any type, for general access by any active HYDRA node. Record-Lock is provided for Relative access Files. Any site with disks may bring them on-line, or simply use them locally (off-line). Host-supported disk access is completely transparent to a running application program within that host. Any number of disk units may be clustered in this way, to construct a Database of unprecedented size and flexibility in the field of microcomputing. Print file-handling is supported within HYDRA which enables real-time remote (or centralised) printing, and MUD supports the creation of Print Files on any remote disk for printer queueing or subsequent off-peak spooling. Neither the disk nor the printer concerned need be local, or even local to each other. Should these two be local,then MUD will support background printing without any BASIC or user program supervision. It will be readily appreciated that isolation of a print run from program execution can remove frustrating delays and improve system throughput, and the goals of resource-sharing, both of disk-units and print facilities, are easily achieved.

HYDRA provides the ability for any site to remotely manage the activities of another site, as part of an Executive option at initialisation. NRUN allows selected nodes to Force-Load and Run programs or other functions at remote sites, which, in a classical distributed processing environment, would allow spare on-line capacity to be used by a supervisory, task-assigning program. However, as the activities of groups of microcomputers tend at this time to be random or non-related, NRUN has been made completely general in application. Quite simply, any remote CBM can be made to perform any function normally available at that site. Applications are immediately apparent in Process-Control systems where unattended consoles or dedicated micros can be force-loaded, started, stopped, or regularly monitored using standard HYDRA functions. In the classroom, the entire group of users can be simultaneously down-loaded with course-material from a central source, which can then Run, Stop or inspect any, or all, student sites at will.

Program Function keys are available to the HYDRA user, whereby groups of lines or strings can be specified as, and invoked by, a single key. Any alphabetic character may be used, and functions may be specified manually or by a BASIC program. This capability can remove much of the tedium of repetitive keyboard input.

Notation and vocabulary.

Site ID's.

Each site (CBM computer) connected to the network via HYDRA has a unique site identification code (for brevity SID) this is an integer in the range 1 to 127. A Site ID of 0 is taken to specify that output is to be broadcast - ie. sent to all sites.
Command entry is deemed to be at the 'local' site; all others are remote.

Format of Command descriptions.

Commands defined here will, for clarity, be in uppercase, variables in lowercase. Optional parts to a command line are bracketed in < >, lines to be entered by the user will be underlined. Commas which are included within an optional segment may not be omitted when that option is exercised, but spaces included for clarity may be omitted from command lines.

Example:-

NPRINT string-expression <,site-ID >

NPRINT is the command, string-expression is a variable and site-ID is an optional variable.

Example:-

NPRINT a$,15 or NPRINT"Message output",15

Most commands containing words which are subsequently Tokenised may be abbreviated as per CBM BASIC.

For the purposes of this document, the term CBM will be taken to mean a CBM microcomputer or PET. CBM and PET are Registered Trade Marks of Commodore Business Machines Ltd.

2 Installation Procedure.

2A. Installing HYDRA:

There are two types of CBM Logic board, which may be identified by the following points;

Connectors J4 and J9, which are to be found at the rear right-hand corner of both boards, are in-line on earlier, 3032/4032-style machines, and off-set on later, 8032/4032 types. Generally, the later boards are found in 12" screen machines. We will refer to the earlier type as 3032 and the later type as 8032 machines.

Having opened the CBM and identified which Logic board is therein, locate the factory-option strapping field adjacent to J9 (3032) or J4 (8032). This may take the form of wire straps, or pre-formed links, each one lettered for identification.

For 3032 boards; cut 'P', make 'N'. For 8032 boards make link 'M'.

This has the effect of allowing external device connection via the Memory Expansion Port; it does not affect operation of the CBM in any way. Turn on the computer momentarily to verify that these changes were successful. *** N.B. 3032 BASIC 4 machines will fail into monitor mode on power-up. *** For the 3032, ROM locations 9, A, and B will now be accessible only via this Port. For 8032 boards, ROM 9 will now be accessed off-board. Definitions of ROM placement will follow shortly.

Locate on the HYDRA board the strapping field marked "Site ID", and note that the printed links are numbered in binary format. Simply select the combination of numbers that adds up to the required Site address, and cut the appropriate links with a craft knife or similar tool. If an error is made or you should wish to change the address, remake the links using the holes provided. (Rapid address changes via a DIL switch or similar have been precluded for reasons of File access security on the Net, and continuity of Networked application programs.)

Next, locate the ROM location B000. This is for 3032 BASIC 4 ROM B ONLY, which, if relevant, should be removed from CBM position UD5 and inserted here. Note the position of the indentation at one end of the ROM, and align it with the indent printed on the HYDRA board adjacent to the socket. **** THIS IS MOST IMPORTANT ****
If in doubt, make a comparison with the ROMs shipped with the HYDRA board.

Now locate ROM A000 on the HYDRA board. For 8032 machines ONLY (refer to the definition of logic board types in paragraph one) this ROM should be removed carefully, using a small blade or screwdriver to ensure even lifting from its socket, and inserted in CBM position UD11. Check for misaligned pins on the ROM after the removal step, and observe the correct orientation as before.

If the CBM has application software in ROM running at 9000 Hex, this ROM will be found in socket UD12 (8032) or UD3 (3032). There is provision on the HYDRA board for this, and the socket is labelled 'User 9000'. Both HYDRA 9000 and User 9000 ROMs remain on this board.

The foregoing ROM mapping procedure is necessary to conform to CBM Memory Expansion Port addressing range constraints, and to transparently manage the co-existence of User software and the HYDRA Operating System in the 9000-9FFF range.

After checking that the ROM placements are correct, locate the single-row HYDRA board connectors over the INNER rows of J4 and J9 (connectors are provided for both CBM types; one connector of the three will be redundant) and press lightly and evenly onto the header pins. Ensure during this step that the HYDRA board remains flat in both directions relative to the CBM board, and that the CBM board does not bow or sag as pressure is applied. IT WILL be necessary to provide support at the side, next to J4, to prevent this.

Locate J11,the power take-off connector at the rear left of the CBM board, and connect the HYDRA power lead. The plug is polarised, and the single lead should exit from the front-most connector slot.

2B. Getting On-line:

To initialise HYDRA, enter: SYS 40960.

The initialisation header will be displayed specifying the version of HYDRA that you are using, and the site ID of your computer. You may then use the enhanced BASIC commands described in this document. All HYDRA commands are preceded by the character "N".

2C. Executive sites.

Some commands are reserved for sites that are in Executive mode; this mode is entered by typing:

***** FOR FORMAT OF THIS COMMAND SEE APPENDIX D *****

The screen will clear to obscure this procedure. The following commands are then available:

NPEEK
NPOKE
NRUN (locally or at a remote site)

Use of any of these commands without first entering Executive mode will invoke a '?SYNTAX ERROR'.

2D. Installation errors:

If Hydra does not initialise, there are some simple tests to establish the cause of the fault; here is a table of errors which can prevent start-up, followed by appropriate pointers.

(a): The BASIC 4 ROM is still on the main logic board (UD5).
(b): The addressing links 'N' and 'P' are not interchanged.
(c): There is no power to the HYDRA board. Check power lead.
(d): Link 'M' is not made.
(e): J4 and J9 connectors are not on inner row of pins.
(f): J4 or J9 connectors are misaligned, sideways or lengthways.
(g): ROM A000 is not on 8032 board.
(h): ROM 9000 is not on HYDRA board.

For 3032 machines:

If PET crashes on power-up check e,f.

If PET enters Resident Monitor on power-up check a,b,c.

If PET crashes at initialisation, restart, enter the Resident Monitor and inspect the A000-AFFF address range. If there is no machine-code displayed then check b,c,e,f,h.

For 8032 machines:

If PET crashes on power-up check e,f.

If PET crashes at initialisation check A000-AFFF address range as above, and then c,d,e,f,g,h.

As the HYDRA board and Software are device independent, one version is used for all machines, and all BASIC types. The only prerequisite is 32Kbytes of store; HYDRA creates buffers in the area 6C00-7FFF Hex, and due to the finite time available for response to Network input at 250KBaud it is not possible to access these buffers via a look-up table, or pointers to memory, which would allow variable store size.

2E. Network connection:

When the foregoing steps are completed and the HYDRA initialisation header is displayed, take the network cable and plug one end onto one of the 5-pin sockets at the corner of the HYDRA board. These are labelled 'Network', and two are provided to allow easy site daisy-chaining for convenience of installation. Inter-node links may thus be modular, reducing on-site cable work. It is not necessary for a site connected in this way to be active or even powered to maintain Network continuity. However, care must be taken when removing devices, that sites 'downstream' are not inadvertently cut off. If mobility of devices is necessary, then a 'star' or radial configuration would be more suitable. It is not important how the Net is physically structured.

2F. Network Termination:

All physical lines between electrical sources have characteristics relating to Impedance (the natural resistance of the wire) and the frequency at which the line is driven. The line can be seen as carrying 'waves' of electricity, a proportion of which is reflected from the ends of the cable very much like water. These reflections distort the next 'waves' arriving and can cause errors in the transmissions. For this reason, on long lines it is necessary to 'damp' the reflections at each end with a resistance, or terminator. It is generally not necessary for groups of machines over small distances; certainly not for the purposes of initial configuring. When the Net is fully operational and carrying data traffic over longer distances then termination is mandatory. Only the two most extreme ends of the cable should be terminated in order to keep line reflections to acceptable limits.

THE TERMINATION OPTIONS on the HYDRA board are found next to the Network connectors, and are labelled T1 and T2. Insert links in BOTH positions if termination is required.

The Network should ideally have two terminated nodes, one at each extremity. It will not matter if more than one site becomes terminated due to Network reconfiguring, or the addition of devices at a later time. Too many terminations will, however, reduce the drive capability of HYDRA line drivers, resulting in reduced performance at extreme distances.

2G. First Steps:

It is advisable to configure a Network of two while first steps are contemplated, in order that the machines may be adjacent and both visible. Remember the addresses of each; we will call them 1 and 2. Enter the following line at one keyboard;

NPRINT"Hello",2 and then key Return.

The message "Hello" will appear on the Target screen, site 2, prefixed by the source site ID. (1) This will occur ONLY if site 2 cursor is at column 1, with the machine in a BASIC READY state. It is not in your interest to be interrupted by a message during say, the construction of a line of a BASIC program. Instead, HYDRA will wait until a Return is entered before presenting a message on the screen. There is room for 1000 characters of message buffering.

If no message appears at 2, check for cursor position at 2, physical connections at 1 and 2, and for correct initialisation of both. If the site ID of either has been forgotten, use an address of 0; this will ensure that ANY site will respond and display the message, including the source address.

When this first communication has been made, in each direction, proceed to the next section.

3
Inter-program communication.

3A. NPRINT

Sends a message to another site on the Network.

Format: NPRINT message-string <,site-ID>

Where message-string is a BASIC string expression, and site-ID is an optional integer expression specifying the destination site for the message. If the site-ID is zero then the message will be broadcast to all sites with HYDRA active. If the site-ID is not specified then the last site-ID used by the NPRINT command will be assumed.

If the target site is not in READY state with its cursor in column 1, the message will be buffered for access by NINPUT. After using the NPRINT command the BASIC variable ST is used to indicate the status of the message. A value of zero in ST indicates that the message was acknowledged by the target site. Should a message not be acknowledged then ST will hold -128 upon completion of the NPRINT command.

Note that when a site-ID of zero is used, HYDRA will broadcast the message to all sites. For this reason hand-shaking is impractical, and as no acknowledgements are expected, ST will always be zero (ie. HYDRA assumes that all sites have received the message).

Example:-

```
NPRINT "hello everybody",0
```

NPRINT CHR$(0), site-ID will operate a remote sounder; CHR$(1) will cancel it.

3B. NINPUT

Inputs a message from another site.

Format: NINPUT string-var1,string-var2

Where string-var1 and string-var2 are both BASIC string variables. The first message sent from a remote site is placed into string-var1 and the site ID of that site is placed into string-var2 as a single ASCII character. This should be interpreted using ASC($var2):
NINPUT is usually used in program mode, as in the READY mode, messages are presented automatically to the user as soon as convenient.

After using the NINPUT command the BASIC variable ST is used to indicate the status of the message; a value of zero in ST indicates that a message was waiting in the input buffer and that it has been transferred to the first string variable, but if there is no message in the input buffer then ST will hold the value 64 (Logical End Of File), and both strings will be empty.

Example: NINPUT a$,s$

3C. NPEEK

Transfers another site's screen contents to your screen.

Format:

NPEEK site-ID

Example:-

```
b=4
NPEEK b      or simply,   NPEEK 4
```

Site address 4 will have its screen contents transferred to the local screen, and the cursor will move to the bottom line.

IF THIS SITE IS NOT IN EXECUTIVE MODE, then ?SYNTAX ERROR will be generated instead. NPOKE is also restricted in this way.

3D. NPOKE

Pokes a program, or screen contents, into another site.

3D.1 Poke a program.

Format:

NPOKE site-id,P

The program resident in the local computer is force-loaded to the remote site specified, along with all BASIC pointers and link variables.

Example:-

```
NPOKE 5,P   (or, to broadcast, NPOKE 0,P)
```

The program resident in this site is transferred to site 5.

3D.2 Poke screen contents.

Format:

NPOKE site-id,S (Broadcast, NPOKE 0,S)

The local screen contents will overlay the screen of the site specified.

Example:-

```
NPOKE 27,S
```

If the command NPOKE site-ID,D is used, then the screen content will be transmitted each time the Shift-key is depressed. This is particularly usefull as a teaching aid; when Shift-lock is used, the screen is transmitted once for any key depression. This means that all addressed sites will reflect the local screen content, key by key, as it is input. This mode is cancelled by any normal Screen Poke, eg. NPOKE 4,S. If a screen transmission is undesirable, use an invalid (off-line) site-ID.

NB: Care must be taken to ensure that programs are not force-loaded over running programs, as multiple crashes will result. All target sites should be in BASIC READY state, and this may be ensured by using NRUN - see 5B.4.

Use Screen or Program broadcast with caution, and only where the Net is configured for that specific purpose.

REMEMBER that these commands and NRUN are for Executive sites only. It will be appreciated that irresponsible use of these Utilities could cause untold havoc on the Network; absolute power corrupts absolutely!

3E. N> Will return the local site-ID into ST for inspection.

Example: N>:?ST will display site-ID.

3F. N+ Will operate the local sounder. This is a general purpose alarm sounder operable remotely, for message annunciation or emergency use. See NPRINT. N- will cancel the sounder.

3G. NSTOP: This forces a return to normal CBM operation; HYDRA exit.

4
Remote file handling.

4A.

HYDRA provides facilities for handling Files that are maintained at another site's CBM disk unit. Up to 50 Files may be opened, of any type (ie. Sequential, Program, or Relative). The normal disk unit limitation on the number of open Relative Files does not apply to Files opened under HYDRA. These Files do not need to be opened at just one remote site, it is possible for one CBM to open Files at 5 different sites (with disk units and MUD active), or any other such combination. Having Files open under HYDRA at a remote site does not preclude opening Files on a local disk unit, so with HYDRA active and a CBM disk unit connected, any site could have up to 10 Files open simultaneously.

The active element that controls the multiple access of CBM disk units is a Multi-User DOS which is loaded from disk, residing in CBM memory. The CBM is technically a disk-host, but all access from the Network via the host is transparent to the user or running application programs. Once MUD is loaded and Run, no further user-intervention is necessary.

MUD must be loaded and active at any site offering disk capacity or print services to the Net. It is NOT necessary at sites accessing these services via the Net. When disk Files are accessed, the disk host will invert its video display to warn local users that this is taking place. Keyboard input is still accepted but the display will freeze momentarily; due to the Network transmission rate, and the corresponding response time allowable, it is impossible for the CPU to generate screen output at this time. The keyboard input buffer still accepts characters until it is full, but if large amounts of data are being moved this may overflow before control is returned to the local program. The limiting factor governing the video 'freeze' is disk access time, as the actual Network transmission time is 0.4 seconds for a 10Kbyte file. For these reasons, screen output should be checked for validity if an unusually long access take place.

One of the most important goals of the System designers was to preserve the identity of disk hosts, minimising the impact of File service on their existing roles. For the user or System builder, this means that the cost of a dedicated CBM need not be added to Network node costs for the privelege of using Files, which would make the Network solution less attractive. Although transparency has been achieved, there is only a given amount of computing power available from each CPU, and no amount of elegant Software will overcome this fundamental limit. For this reason, it cannot be expected that one disk site can serve an unlimited number of users without throughput penalties. System builders can, however, due to HYDRA node autonomy, cluster disks to build capacity with speed.

There is of course a memory penalty incurred by use of MUD, as File buffers and workareas are needed, as well as the area of DOS machine-code. However, this loss of CBM workspace is outweighed by the capacity of EACH site to manage up to 50 open Files of any type, for general access.
One host CBM and MUD could serve the entire Network of users, or, for example, 5 disk sites can offer the Network 250 currently open Files. Obviously, this level of File activity will rarely be achieved, but the spin-offs in terms of flexibility of data management will be apparent.

The following commands apply to the use of MUD, the Multi-User DOS provided on disk with your HYDRA boards. MUD should reside in CBM memory space at the sites providing disk or printer services to the Net.
It should be loaded via the MUD-Loader, which will also initialise HYDRA.

4B. NREM

Sets locally the current remote site address that further File commands will refer to.

Format:

NREM site-ID

Where site-ID is a BASIC integer expression in the range 1 to 127.

NOPEN, NLOAD, NSAVE all assume the site-ID defined by NREM to be the controller of a CBM disk, which has MUD active.

Example:-

```
NREM 5
```

To open Files at multiple remote sites, simply issue an NREM prior to each NOPEN command, specifying the respective disk or printer site. This address is used by MUD for all further access to that File until it is closed. Remember that NREM defaults to the last value specified, or to 255 if none has been defined.

4C. NLOAD

Loads a Program File from a remote disk.

Format:

NLOAD file-string

Where file-string is a BASIC string expression, and is the name of the program to be loaded from disk. The last NREM statement defines the site ID of the CBM disk drive where the program is expected to reside. NLOAD behaves in much the same manner as the BASIC 3 LOAD instruction except that the program will not run automatically if the NLOAD statement was within a running program. All disk errors (eg. File not found) are displayed upon the screen (and contained within ds$, BASIC 3 and 4).

Example:-

```
NREM 9
ready.

NLOAD "prog"
```

Would define site 9 as a disk handler, and then load "prog" from it. Prog must, of course, exist at that site.
NL shift-O may be used as per CBM BASIC.

4D. NSAVE

Saves a BASIC Program File to a remote disk.

Format:

NSAVE file-string

As in NLOAD, file-string is a normal BASIC 3 file-name (preceded with the @ sign if a File is to be overwritten).

Example:-

NSAVE "@0:program-1"

Would save the current BASIC program as "program-1" on drive 0 of the disk that was last defined by an NREM statement. A device address of 8 is assumed by MUD for IEEE purposes.

4E. NOPEN

Opens a File at a remote site.

Format:

Same as a BASIC 3 OPEN statement.

A physical address of less than 4 will generate a 'DEVICE NOT PRESENT ERROR'. NREM will have defined the remote site.

If you attempt to Open a printer channel at a remote site, and it is already Open (to another site) then a "DEVICE ALLOCATED" message will be returned.

4F. NCLOSE

Closes an open File.

Format:

NCLOSE logical-file-number

Example:-

NCLOSE 4

Closes logical file number 4. (LFN 4)

RUN closes all Files. If it fails to, or does not run, check that a previously NREM defined disk site is still on-line, as RUN cannot close files at a site which has left the Net. No File activity need have taken place (including Load and Save) after the NREM. If such a condition prevails, enter NREM 255 and Run. This will allow your program to continue, but the validity of any CHANGES made to Files, which are left unclosed in this way and manually closed locally, not via MUD, must be suspect.

4G. NCMD

Redirects screen output to a printer.

Format:

NCMD logical-file-number

All further output to the screen is redirected to the open File. This facility can be used to produce listings upon remote printers, or to create Spool Files on disk. These would subsequently be accessed via the Network by BASIC programs or by MUD background printing routines. MUD must be active at a printer host site; it is therefore logical to have disks and printer at the same site to minimise MUD OS storage needs.

Example:-

```
NOPEN 4,4     :REM open printer at remote site.
NCMD 4        :REM redirect all output to the printer.
LIST          :REM list the current basic program.
NCLOSE 4      :REM close the printer.
```

H. NPRINT#

Same as BASIC 3/4.

These File commands all operate remotely at sites specified at the NOPEN by NREM.

4I. NINPUT#

Same as BASIC 3/4.

4J. NGET#

Same as BASIC 3/4.

4K. NRECORD#

Defines the next record to be processed within a Relative File.

Format:

NRECORD#logical-file-number,record-number

This sets the File pointers to the appropriate record; the next NINPUT# will read this record, the next NPRINT# will overwrite it. Any following NINPUT# will read the following record as normal.

If a File is opened by more than one site, then a Record-Lock technique is used to ensure File integrity. The Record-Lock prevents a record in a Relative File from being read (ie. Input) by more than one site at one time. When a record is read, it is prevented from being re-read until another record is accessed by the first user. In this way updated records are guaranteed to be valid despite multiple access/modification.

*** The message "LOCK-OUT" will appear at the bottom of the screen *** if a program is waiting for a record to be released. ***

4L. NCATALOG

Retrieves the Directory from a remote disk unit defined by NREM.

Format:

NCAT"$" (or $0, $1) (shifted 't' for short.)

BASIC 3 sites will use N* "$" (or $0, $1)

(BASIC 4 sites may also use N* for convenience.)

A further option under NCAT is partitioning of Directory entries. This is of particular value for multiple-access disks which may contain lengthy Directories due to the very nature of their use on the Network.

Format:

NCAT"$:p* where p is the partitioning string.

or: N*"$:p* for BASIC 3. (optional BASIC 4.)

All Files beginning with the specified string will be listed. With responsible use of prefixes, this will partition Directory output for each user of the disk addressed. If prefixes are used by only a few disk users, simple probability of first-character coincidence will refine Directory lists for each of those users.

When directory lists are scrolled on the screen for inspection,it is customary to key 'rvs' in order to slow the scroll. If the directory is accessed via MUD, extended use of 'rvs' will result in a 'time-out' error at the local site, and curtailment of the directory listing. This is because MUD has a lot to do, and quite reasonably does not want to spend too much time serving up the odd directory entry, to the detriment of other queued requests. For this reason also, the previously described partitioning character or string should be used to minimise screen output.

5
Program control

5A. General description.

HYDRA provides a feature called NRUN, for queueing commands at a remote site (or even locally if desired). This feature is very useful because it allows you to simulate local control of a machine, but at a distance, giving you control of the computer exactly as if you were sitting there typing the commands. Users who have worked with mainframes will recognise this feature as being similar to JCL (or EXEC., with IBM).

5B. Substitute characters.

Some characters are difficult to place within a string in BASIC; HYDRA allows you to replace these difficult characters with more easily represented ones, and will reconvert them before they are inserted into the command buffer.

5B.1 Quote substitution.

If you wish to include a quote (") in your command string, you will find it is more easily done by typing apostrophe (′). HYDRA will convert this character to a quote character before queueing it for execution.

5B.2 Carriage return substitution.

As with the quote character, the carriage return is not easily placed into a BASIC string, so a special character has been defined as being a substitute for the carriage return. The back slash character (\) is used to represent the carriage return.

5B.3 Escape substitution.

Sometimes it is NOT required that a character should be translated into another, as in 5B.1 and 5B.2. If you do not want a back-slash or apostrophe to be translated then you should precede it with the back-arrow (←) character. If you need the back-arrow to be placed into your string, then you should precede it with a back-arrow.

5B.4 Break key

If a break-key character (ASCII 03) is in the command queue, then a break will be forced when it is executed. This is useful when the command string is to be sent to a remote site, as it will stop any BASIC program that may be running. Refer to the previous descriptions of NPOKE and program broadcast in 3D.1.

5C. NRUN: Control of a local program.

Format 1:

```
NRUN string-expression
```

Example 1:-

```
NRUN"?'hello'\"
```

This will force the following command onto the local screen as it executes;

```
?"hello"
hello

ready.
```

Example 2:-

```
NRUN"nrun'? 'hello ' \'\"
```

This will generate the following screen output as the command queue is processed;

```
nrun"?'hello'\"

ready.
?"hello"
hello

ready.
```

5D. NRUN: Control of a remote program.

Format 2:

```
NRUN string,site-id
```

Example 3:-

```
NRUN "run\",65
```

In this format the string is sent to the site specified and executed there, as in Format 1 above. The example is actually a remote forced-Run. If the local site is not in Executive mode then ?SYNTAX ERROR will be displayed, and no output will be generated.

6
Program Function Keys

6A. General description.

It is often the case when using a computer that a programmer/user will have to type the same group of lines many times during a session. To speed up this process and to reduce errors, a facility called "Program Function Keys" has been built into HYDRA. This facility allows a user to define a group of lines or a function and save it as a two-character code that he/she can activate whenever required.
A buffer has been set aside in HYDRA to store these Key functions, which remains active until the computer is switched-off or HYDRA is re-initialized. Functions may of course be defined from within a program.

6B. Creating a new function.

Format:

↑letter=string

The BASIC string expression is saved as the letter specified.

Example:-

```
↑k="PRINT'this string is saved as the letter k'\"
```

The format of the string and its substitution characters is the same as the string in an NRUN statement. In the example above, the print statement is saved as the letter 'k'.

6C. Invoking a saved string.

Format:

↑letter

The string saved as 'letter' is placed into the command queue (as with NRUN).

Example:-

```
↑k      when input at the keyboard will generate on the
        local screen;

?"this string is saved as the letter k"
this string is saved as the letter k

ready.
```

6D. Deleting a saved function.

Format:

↑letter=

This will remove the named function from the buffer.

Example:-

↑k=

Function 'k' is removed from the buffer

6E. Displaying functions.

6E.1 Display function names

Format:

↑?

This will list all of the names (ie. letters) of the strings saved by HYDRA.

Example:-

↑?	will display;
k, m, t, x	on the screen.
ready.	

6E.2 Display the body of the function.

Format:

↑letter?

This will list the string that is represented by the letter specified; the string is displayed in the same format as the creation string so that the user may edit and replace it.

Example:-

↑k?

↑k="?'this string is saved as the letter k'\"

ready.

7.

General Notes on HYDRA usage

7A. HYDRA uses CBM memory area 6C00-7FFF Hexadecimal (27648-32767) for input buffers, data I/O management and other routines. BASIC pointers are adjusted at HYDRA initialisation, but machine-code programmers should be aware of this requirement. Also, any direct Pokes into the CBM Operating System such as CHRGET wedges, or changes to the IRQ vector, should recognise HYDRA routines.
See Appendix E for an extensive description of machine-code entry points and their required parameters.

7B. User ROM space at 9000-9FFF Hex. (36864-40959) will be bank-switched by HYDRA software automatically, but any user code at 9000 should be aware of HYDRA activities in Ram.

7C. One of the most common messages that you will see initially is

255 off-line

This means that you forgot to specify NREM before Loading a program from a remote disk, and it has defaulted to 255.

7D. The fastest way to Load a program into multiple sites is to Load from disk and then Broadcast with NPOKE0,P. The transmission will take a fraction of a second. Beware of Broadcasting ANYTHING unless the Net is configured for a specific purpose (such as teaching or student monitoring). Net users engaged in other tasks will not appreciate it.

7E. If incoming screen messages scroll too fast, key 'rvs' for slow scroll, or move the cursor off column 1 (with the space bar, say) to stop the display. Resume with cursor-left or Return.

7F. NPEEK works so fast that you may not notice the transition, especially if similar screens are being PEEKed, for example within a loop in a BASIC program. It will help if the local screen is cleared prior to each NPEEK, so that the new screen content can be seen to be fresh. Also, avoid PEEKing a site at an unecessarily high rate, such as 10 NPEEK5:GOTO 10. This will simply occupy Net time wastefully, as 2000 characters are transmitted for each loop. Also, the target site will be totally pre-occupied with supplying screen information and will have little time for normal processing. Use a loop with a meaningful time-delay.

Dis-similar screen sizes will display as much of a PEEKed screen as possible. I.E. 40 column screens will only present half of an 80 column display.

7G. For a Tutorial or multiple-display application, the most usefull command is NPOKE 0,D which will broadcast the local screen once for each Shift-key depression, or once for each key-stroke if Shift Lock is engaged.

7H. Relative-record Files may not be created remotely, and no Syntax exists within HYDRA to do so. As a general rule, remote sites may only USE files, and are not permitted to make major changes to the contents of media at remote sites, by deletion of Files or other potentially 'fatal' operations; it is more secure to structure and manage the media at the relevant disk site. Sequential and Program Files will be created by the NOPEN or NSAVE commands as normal.

7I. Remember that the File structure is absolutely standard CBM. The ONLY changes to existing BASIC programs will be the addition of NREM to let HYDRA know where on the Net the disk unit(s) are, and the prefixing of commands with 'N'.

7J. Multiple access to Files will, in practice, seem to be as fast as single-user access. This is because under normal conditions each user-access is unlikely to coincide precisely with another, and in that event, at times of heavy disk useage, disk run-up time will be eliminated as MUD queues incoming File requests and retrieves records 'on the fly'.

7K. Program loads will take between 0.1 and 0.7 seconds longer than normal, depending on program size. If a File-access coincides with a Program Load (or Save) at a disk site, the requests will be serviced on a first-in, first-out basis. This means that a File access may be delayed while the Load takes place; at the remote site a 'WAITING FOR BUFFER FREE' message will be displayed. This does not affect any transactions between other sites on the Net, as Program Loads are transmitted in small 'bursts' or packets which keep pace with the data from the disk. A simultaneous Load between two other sites on the same Network would travel 'crosswind' as it were, packets interleaving under control of the Carrier-Sense circuitry.

7L. During heavy File activity, the disk host screen will invert its background frequently as each request is processed. Keyboard input is still accepted while this takes place, and each time the screen returns to normal (usually after 1 - 1.5 seconds) the Keyboard buffer is emptied. Generally, an operator will not fill the buffer faster than it is emptied except during a Program Load, when it may overflow; if the display is inverted for longer than 3 - 4 seconds, check the current screen line for validity.

7M. If several NRUN commands are issued to one site at one time, they may overwrite each other while the leading NRUNs are operating. To avoid this, place all the NRUN commands for immediate execution at a particular site in one BASIC line, and they will be executed in entirety in the correct sequence.

E.G. NRUN "NREM5\ NLOAD'prog'\ run\",3

This line will force site 3 to define (to itself) site 5 as a disk host, Load "prog" from site 5, and then Run "prog". The 'Break' key is a legitimate NRUN function and will operate remotely.

Appendix A. COMMAND SUMMARY

Network Communication Commands.

NPRINT "string" <,site-id>

NINPUT msg$,from$

NPEEK site-id	EXEC. only.	(Screen)
NPOKE site-id,P	" "	(Program)
NPOKE site-id,S	" "	(40 char.)

File Handling Commands.

NREM site-id

NLOAD "file-name"

NSAVE "file-name"

NOPEN logical-file-numb,primary-address <,secondary-address,"file-name">

NCLOSE LFN

NINPUT#LFN,variable-list

NPRINT#LFN,expression-list

NGET#LFN,variable

NCMD LFN

NRECORD#LFN,record-number

Program Control.

NRUN "string"

NRUN "string",site-id

Program Function Keys.

↑letter="string"

↑letter

↑letter=

↑letter?

↑?

Appendix B. Error message summary.

In the following list of error messages, the % sign is used to represent the position of a site ID.

Messages generated by HYDRA

All of the following messages can be generated by HYDRA:

?% off-line

The named site is not connected to the network, or Hydra is not initialised at that site. This error can result from any command that uses the network. 255 off-line means that NREM has not been defined and has defaulted to 255.

?% not disc handler

The named site is not a disk host (eg. does not have MUD active).

?device not present

An NOPEN command has been issued containing a device address that is not available at the remote site.

?time-out error

HYDRA expected a reply which did not arrive within a pre-set time. Can be caused by slow response of a program to Network requests.

?file open

Generated by trying to Open an open File. NCLOSE it first.

?file not open in this mode

Generated by trying to use a closed File, or from reading a File which is open in Write mode, or writing to a file open in Read.

?too many files

NOPEN used with 5 remote Files open already.

Waiting for free buffer

The 1000 character buffer in the target CBM is full. This message is self clearing when buffer space becomes available, or may be exited with the BREAK key.

Waiting for disc / loading

Momentary message - disk is busy / loading data to local site.

Error messages cont.

Device allocated

A requested device (usually a printer) is in use.

Lock-out

The local site is waiting for a Record to be unlocked.

Disk Status

Is returned as normal after disk operation. Bad Status will Break running programs.

Appendix C. INDEX.

Background Printing	Page 4
Broadcast Programs	Page 4,3D,7D
Command Summary	App.A
Carrier-Sense Multiple-Access	Page 3
CBM Logic board types	2A
Error messages	App.B
Executive sites	App.D, 2C
Files, capacity	4, Page 4
Files, closure	4F
Files,creation	7H
Files, MUD	4, Page 4
Files, pointers	4K
Files, Print	4G, Page 4
Files, Relative	4,4K
Files, remote	4E,4G
First steps	2G
Forced-Load and Run	Page 4
Force-loading programs	Page 4,7M
ID, site: or Site ID	2A,3A,3B,4B
Initialisation of HYDRA	2B,App.D
Installation errors	2D
Installation procedures	2A
Local Area Network	Page 2
Lock-out	4K, App.B
Memory Expansion Port	2A
Memory Useage	7A,7B
Message buffers	2G,3B
Message passing	3A,3B,2G
NCATALOG	4L
NCLOSE	4F
NCMD	4G
NGET#	4J
NINPUT	3B
NINPUT#	4I
NLIST	4G
NLOAD	4C,7K
NOPEN	4E
NPEEK	3C,7F
NPOKE	3D,7G
NPRINT	3A
NPRINT#	4H
NRECORD#	4K
NREM	4B,4H,7C
NRUN	5A,C,D
NSAVE	4D
NSTOP	3G
N>	3E
N+,N-	3F
Network configuring	2E,2F,2G
Network connection	2E
Network medium	Page 3
Network speed	Page 2,3

Appendix C. INDEX.

Background Printing	Page 4
Broadcast Programs	Page 4,3D,7D
Command Summary	App.A
Carrier-Sense Multiple-Access	Page 3
CBM Logic board types	2A
Error messages	App.B
Executive sites	App.D, 2C
Files, capacity	4, Page 4
Files, closure	4F
Files,creation	7H
Files, MUD	4, Page 4
Files, pointers	4K
Files, Print	4G, Page 4
Files, Relative	4,4K
Files, remote	4E,4G
First steps	2G
Forced-Load and Run	Page 4
Force-loading programs	Page 4,7M
ID, site: or Site ID	2A,3A,3B,4B
Initialisation of HYDRA	2B,App.D
Installation errors	2D
Installation procedures	2A
Local Area Network	Page 2
Lock-out	4K, App.B
Memory Expansion Port	2A
Memory Useage	7A,7B
Message buffers	2G,3B
Message passing	3A,3B,2G
NCATALOG	4L
NCLOSE	4F
NCMD	4G
NGET#	4J
NINPUT	3B
NINPUT#	4I
NLIST	4G
NLOAD	4C,7K
NOPEN	4E
NPEEK	3C,7F
NPOKE	3D,7G
NPRINT	3A
NPRINT#	4H
NRECORD#	4K
NREM	4B,4H,7C
NRUN	5A,C,D
NSAVE	4D
NSTOP	3G
N>	3E
N+,N-	3F
Network configuring	2E,2F,2G
Network connection	2E
Network medium	Page 3
Network speed	Page 2,3

Network termination	2F
Print, background	Page 4
Print spooling	Page 4
Program down-loading	Page 4,7D
Program broadcast	Page 4,3D,7D
Program-program communication	3A,3B
Program Function Keys	6, Page 4
Record Lock	4K
Relative Access Files	4A,4K
Remote computer control	5A,5B.4,5D
Remote File Handling	4,7H-L
Remote Loading/Saving	4C,4D
Remote Printing	4B,4E,4G,Page 4
Remote program control	5A,D, Page 4
ROM placement	2A
Site ID	2A,3A,3B,4B
Screen Inversion	4,7L
Screen Poke	3D.2,7G
Software, HYDRA	Page 4,
Software, Multi-User DOS	Page 4, 4 all
ST, Status byte	3A,3B
Substitution characters	5B
Syntax errcrs	2C,3C,3D
System Overview	Page 2
User ROMs	2A, Page 4,7B

Appendix D — Executive sites.

Certain HYDRA commands are reserved for sites in Executive mode. This mode is entered by typing:

SYS 40963

The screen will clear to obscure this procedure. Executive commands are then available to this site; ie. NRUN, NPEEK, NPOKE.

It needs no explanation that unrestricted use of these commands could cause havoc around the Network, and for this reason their use should be limited. Ideally, an application program would best exercise the facilities, or manual control by a Tutor or Network Supervisor. It will be the responsibility of that Supervisor as to whom the facilities are afforded.